THE SECRET OF PLANTS IN THE ENVIRONMENT

RISHIKESH UPADHYAY

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notionpress.com

INDIA • SINGAPORE • MALAYSIA

Notion Press

Old No. 38, New No. 6
McNichols Road, Chetpet
Chennai - 600 031

First Published by Notion Press 2020
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ISBN 978-1-64850-920-9

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This endeavour is dedicated to

The memory of his father, Late PITAMBER UPADHAYA,

and for investing his gesture of heart upon his mother,
Smt. NANDAKALA (Bawni) UPADHAYA

and sister, Ms. SANDHYA UPADHYAY

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Acknowledgements

The author records his heartfelt thanks to all those individuals, their surperb views, including grammatical alerts, for improvement of the glitches, proofreading, criticisms, useful tips, constructive comments, plagiarism and other suggestions.

He would like to communicate his appreciation to his students, past and present, in the Department of Botany, Haflong Government College affiliated with Assam University, India for their helpful comments and stimulating conversation.

His gratitude is also due to those individuals or persons whose names have not been mentioned herein the acknowledgements, but whose views have directly or indirectly been highly beneficial in the presentation.

He would like to thank and greet S. Shruthi, Grace and V. Menon of Notion Press Publication, for their efforts from shaping to bringing out his book to the hands of the esteemed readers.

And finally, he profoundly recognizes the support of his brothers and sisters whose constant helps and blessings for every success in his endeavour have made this presentation possible in the hands of the esteemed readers.

Thank you.

Author's Note

Plants are the fundamental aspects of our biosphere. In nature, plants may be exposed during their ontogeny to a wide variety of favourable or harmful stress factors or environmental changes. The growth, behaviour and variations of plants in response to various environmental stresses differ in different plants; they are modified in the same species by the climate and surroundings to which the plants become habituated. Several phenomena of daily or diurnal periodicity in plant are known, but the relationships between the two are more or less obscure. Due to the gravitational stimulus, the roots of plants move downwards and the shoots upward; the sprouts are directly affected by natural environmental changes from the initial growth of plants to their maturity.

This book is an outcome of the painstaking acquisition of knowledge, experience and learning regarding plants and their relative environments that inspired the author during the course of teaching and performing research. The book intends to provide a synthesis of knowledge on the adaptation pathways induced by environmental changes or stressors, such as drought, chemical agents, electric stimulus, mechanical stress, magnetic fields, flash-flooding, submergence, biotic stress, waterlogging, mineral nutrients, freezing, radiation stress, high salinity, temperature fluctuations, pollution, heat, heavy metal stress and light stress.

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Prologue

This plant represents what's happening inside of you. The world, like the soil, is cold and dark - layered with a history of destruction and death. You were planted in this world to rise above it. Do you not see? The very existence of this darkness gives you the opportunity to become a light to the world.

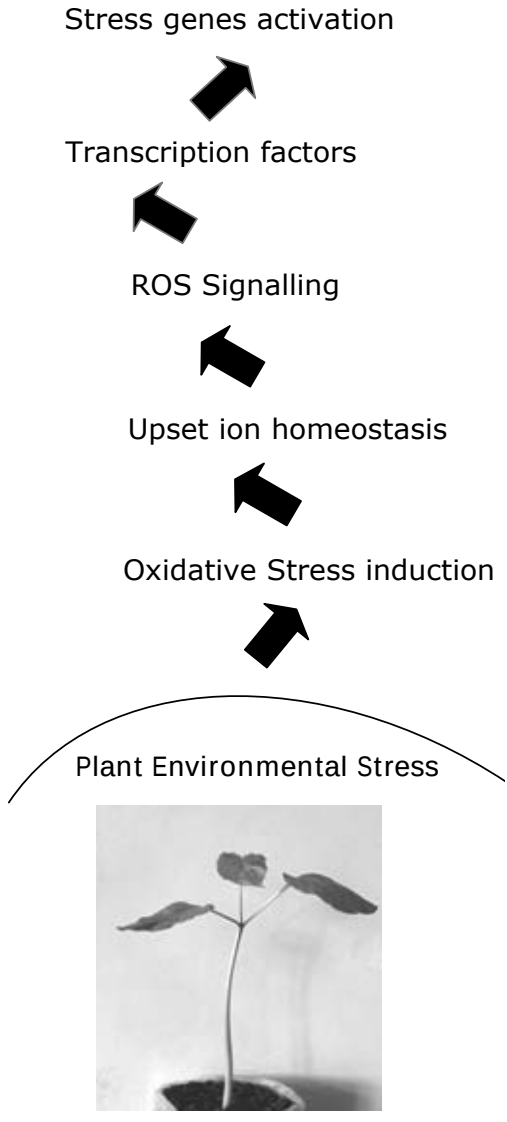
– Seth Adam Smith,
"*Rip Van Winkle and the Pumpkin Lantern*"

The quality of our life depends on the quality of the surrounding environment. Photosynthesis is central to all aspects of plant biology as the provider of energy and assimilates for growth and reproduction, but how it is regulated by abiotic stresses, such as salinity and water deficits, and by biotic stresses, such as insect herbivory, has not been determined. In some cases, plants communicate with their tissues and organs to synchronize their responses to changing natural environments. As plants lack a central nervous systems, their sensing and communicating mechanisms are slightly different from animals. Understanding the physiology of stress, either biotic or abiotic, or different environmental changes in plant growth and development, are important to many environmentalists and plant scientists because physical stress has a prominent

impact on biological diversity and agricultural productivity, as well as other environmental and ecological maladies in nature.

As sessile organisms, plants must cope with different environments, such as soil salinity, drought, and extreme temperatures. Plants have developed suitable mechanisms to adapt to these environments during their long evolutionary history. In response to stressful conditions imposed by their environment, which could affect growth and development throughout the plant life cycle, plants must be able to perceive, process, and translate different stimuli into adaptive responses. Knowledge about the plant stress response is vital for the development of breeding and biotechnological strategies to improve stress tolerance in crops and, consequently, crop yields. Curtailing crop losses due to various environmental stressors is a significant area of concern to cope with the increasing food requirements. Proteins are essential constituents of the cell that are easily damaged under environmental stress condition. There is a degree of inherent circularity in the definitions of the terms stressor, stress and stress response, and part of the confusion surrounding these concepts may arise from a lack of precision in the distinctions between them and the word stress. Thus, pressure is often used somewhat loosely to refer to both environmental factors causing its response. Stressors are environmental factors that cause stress in plants. Stressors include biotic factors, such as food availability, the presence of predators, infection with pathogenic organisms or interactions with conspecifics, as well as abiotic factors, such as temperature, water availability and toxicants. Responses to stress are thought

to ensure short-term protection of plants followed by the formation of specific adaptation mechanisms. An extensive study on oxidative stress has demonstrated that exposure of plants to adverse environmental conditions induces overproduction of ROS, such as superoxide radical ($O_2^{\cdot -}$), (H_2O_2) and hydroxyl radical ($OH^{\cdot}$), in plant cells [**1**]. As a consequence, plants have evolved cellular adaptive responses such as the upregulation of oxidative stress protectors and accumulation of protective solutes. Among the non-enzymatic antioxidants, ascorbate is found to be one of the best-characterized compounds, required for many vital metabolic functions in plant cells. Ascorbate acts as an antioxidant, protecting cells against oxidative stress. Ascorbic acid can eliminate different ROS, including singlet oxygen, superoxide and hydroxyl radicals.



1. General responses of plant to Environmental Stress.

CHAPTER ONE

Appliance of Plants

All human affairs follow nature's great analogue, the growth of vegetation. There are three periods of growth in every plant. The first, and slowest, is the invisible growth by the root; the second and much accelerated is the visible growth by the stem; but when root and stem have gathered their forces, there comes the third period, in which the plant quickly flashes into blossom and rushes into fruit. The beginnings of moral enterprises in this world are never to be measured by any apparent growth... At length comes the sudden ripeness and the full success, and he who is called in at the final moment deems this success his own. He is but the reaper and not the labourer. Other men sowed and tilled and he but enters into their labours.

— Henry Ward Beecher, "*Life Thoughts*"

Even if we do not have all of the answers regarding areas with the potential to receive rainfall, we can be sure that there will be rain if plants are present. Downpours occur in forest or plantation areas at least once in twelve months. One cannot exactly state how the relationship between nature and forest areas developes; for example, it requires

more than clairvoyance to determine the truth about the relationship between the human race and nature. The exact mechanism seems to be complex because of the vastness of the term nature. The more that researcher describes it subjectively, the more it becomes exhaustive, for the term holds relative importance everywhere. In this context, air, water and soil represent the primordial needs of all living beings, including plants, upon which we will expatiate.

The plants in our environment present a majestic greenness that attracts both humans and animals with respect to different tastes.

However, it is known that the presence of trees in soil ensures the restriction of erosion problems.

Retaining the aforementioned perspective, we established a series of objectives regarding the scrupulous use of soil and water via the adaptation of eco-friendly measures.

First, we motivate people towards the adaptation of alternative methods of production via the implementation of scientifically viable schemes to raise the economic conditions of the poor people in the Dima Hasao District.

Second, we place more emphasis on eliminating old habits by introducing the Cash Crop Development Scheme, which consists of rubber, tea, cardamom, and broom plantations, among others, as a substitute for food production for their livelihood.

Additionally, in the course of implementing the afforestation plantations, the government of India suggested the convergence of agriculturale crops towards

the introduction horticulturale plantations, such as ginger, turmeric, papaya, lemon and dagger plants (*Agave Americana*) under the existing plantations of rubber. The convergence helps erect a vegetative barricade for gazers, as well as for illegal felling of trees in departmental afforestation. The aim of the literary erection of the fence is to attract people who, in turn, will help check the regular felling of trees from plantation fields.

Moreover, the convergence ensures some financial returns for the villagers who adopt it in the plantation fields.

Apart from the two types of plantations in one field as described above, we have also planted ornamental plants in and around our residential areas.

For the protection of soil, such measures as bench terracing, land reclamation, and gully control works have been adopted for the conversion of the abandoned land after shifting cultivation by the villagers of the hilly regions of Assam. These schemes attempt to help cultivators adopt wet cultivation.

Furthermore, there are water bodies everywhere at their location site.

The plantations that have no human control may well be described as forests, which can be classified into two types – reserved and unreserved. The former case, remains under the regular control of the forest department for the preservation of the flora and fauna of the particular areas selected for carrying out the particular role by the particular department of the concerned government; in contrast, the

unreserved forests remain under the control of the state land, revenue and settlement department.

The protection of living beings ensures the protection of the environment from hazards, and, in the same way contains the erosion to control the depletion of forests.

To evaluate the scarcity of water, we assess the degradation of forests, for which the Government of India's recently launched the water conservation mission, which is popularly known as *Jal Shakti Abhiyan,* in which the implementation of vigorous plantations of saplings has been conducted. This mission will certainly help to streamline the protection of ecological and environmental imbalances.

Such plantations ensure the tightening of loose soil, which, in turn, prevents runoff water from the rainy season from washing away the topsoil that causes erosion. The losses of fertile soil also cause excess exposure of rocks underneath the soils, generating unbearable weather conditions for the denizens of the Earth.

What is soil? When we think about soil, we begin to use and think of it throughout our conscious and unconscious movements. Our entire movement on the outer surface of soil is also known as Earth.

From our footing to sleeping on our beds via the support of wooden or iron coats, the role of the outer surface of soil, which is also known as Earth, is present from our birth to our death. Considering the wonder of the adaptation of human lives to Earth, we humans conferred the Knight of the Mother to the outer surface of soil.

Since we need air and water for life on Earth, better treatment of the outer surface of soil is indispensably necessary to ensure natural air and water in our planetary life.

As the green coverage of soil dwindles due to the wanton destruction of forests, as well as to conflagration, the original sources of streams and rivers are naturally bound to either become saturated or threatened, portending the slow and steady decline of the water tank below the lower surface.

Commenting on the purpose of our life in the universe, Dr. Albert Einstein once said, "If the universe is an accident, we are accidents. However, if there is meaning in the universe, there is meaning in us also"

Based on the same syllogism, let us presume that all living beings have a purpose of life on Earth. Although it is not possible for everyone to simultaneously determine who or what is born for what purpose on Earth, it is clear that every living being has a purpose and or right to live in the universe – for instance, if someone is devoted to creation, another is actively engaged in destruction; if one is good, the other is evil; if one is a saint, the other is a sinner; if one is a meat eater, the other is a vegetarian, etc. Hence, no one can imagine any permanent destruction of the other based on the principle of our performance, although efforts are sometimes exerted out of expediency.

The wanton destruction of forests not only deprives the existence of green habitats, but also the wildfires that spread from the fields of shifting cultivation wreak havoc with the lives - and visible properties in the case of the human race - of all living beings in particular regions of conflagration.

Regardless of agreement about the matter, when the right to existence of others is eliminated, we extricate the role of an individual from his share of equal contribution towards a peaceful co-existence between humans and other living beings, thereby violating our own conscience of protecting ecology for a better environment.

In view of the rapid growth of the human population, the use of land, or, for that matter soil, becomes haphazard. As long as our need for land is limited, the danger of erosion becomes serious. For our benefit, we use the soil according to our personal needs, and not for the overall benefits of all people in our environment.

To streamline the same phenomenon, it is presumed that it actually leads to the birth of the need for the formation of think tanks at international, national and state levels. In addition, its creation for the necessity of framing certain rules ensures a safer earth. In the aftermath of erosion caused by the loss of alluvial soils, the rise of riverbeds becomes inevitable following the deposition of the washed away particles by the runoff water from the rainy season.

It may be stated that the need to preserve the environments of human beings has already been felt by conscientious people. However, in implementing remedial measures, our mission towards protecting these environments has in turn changed or our efforts have often not been given the chance to bear fruit, precisely because of the lack of strong determination or resolution.

The rise of river basins causes floods that wreak havoc with the lives and properties of humans in Plains areas.

Further, there is a standing problem of shifting cultivation in some tribal belts in India, where the system of growing food for livelihood consists of large-scale destruction, as well as burning of pristine forests.

Following the wanton burning after the felling of trees from unclassified forests, farmers uproot stumps from their cultivation land. The result of the displacement of stumps of cut trees leads to loosening of the soil, enabling the rain water to sweep away all fertile soils from low-laying areas.

In this context, the good governance motivates farmers to adopt a settled cultivation, which is popularly known as wet cultivation, for which some measures, such as bench terracing and contour bounding, have been introduced in the field to meet the basic requirements for implementing the schemes.

In short, all our activities pertaining to the protection of the environment directly or indirectly emerge from the need to grow plants for the survival of humans and other living beings. When planting trees, various kinds of stress are experienced by the plants. Having dwelt on the importance of plants for living beings, we turn to the study of the management of stress or environmental changes in plants.

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